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ABSTRACT OF DISCLOSURE

Disclosed is a procedure for the production of mechanical pulp from a fibrous product. To reduce a refining energy, the fibrous product is subjected to an enzyme treatment in which an enzyme acts on lignin in the fibrous product. When oxidizing enzymes are used, it is preferable to adjust the redox potential to the optimum level characteristic of each oxidation-reduction enzyme by means of suitable oxidation-reduction chemicals. In addition to reducing the refining energy consumption, the enzyme treatment also improves the strength properties and the blue reflectance factor of the pulp.

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PROCEDURE FOR THE PRODUCTION OF PULP

The present invention relates to a process for the production of mechanical pulp from a fibrous product.

The production of mechanical pulp from a fibrous product, such as whole wood, wood chips, chips or refined pulp is mainly implemented by mechanical methods. The production of mechanical pulp is based on the utilization of friction. Energy is transferred to the wood in a compress-release process generating frictional heat which softens the wood so that individual fibres can be released.

Traditionally, mechanical pulp is produced either by grinding or refining. These methods have the disadvantage of a high energy consumption, but they also have the advantage of a high yield (about 95%). In more advanced versions of the refining method, heat (TMP, thermomechanical pulp) and possibly also chemicals (CTMP) are used. Moreover, it has recently been established that the energy consumption in the defibration and refining of wood can be reduced by allowing white-rot fungi to act either on wood chips or on pulp produced by a single refining operation. However, this method has the disadvantage that the required reaction time is several days, sometimes even weeks. Besides, the reaction requires sterile conditions. These circumstances are an obstacle to large-scale and economical utilization of the method.

An object of the present invention is to create a solution that allows the refining energy requirement to be reduced

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from its present level. According to the invention, the fibrous product is subjected to an enzyme treatment in which an enzyme acts on lignin in the fibrous product. When the fibrous product is treated with enzymes acting on lignin, generated e.g. by white-rot fungi, in the presence of suitable deoxidants, antioxidants or salts, a reduction in the refining energy is achieved even if a short reaction time is used, and no sterilization of the raw material is necessary.

10 In the procedure of the invention, the raw material subjected to enzyme treatment may be either whole wood, wood chips, or pulp refined one or more times. However, the enzyme action requires a good contact with as large a fibre area as possible.

The purpose of the enzyme treatment is to modify the structure of the lignin in the fibres in such a way that the fibres will come apart more easily during mechanical refining. The desired result is achieved by treating the fibrous product with an oxidizing enzyme and adjusting the redox potential with a suitable oxidation-reduction chemical. The enzyme to be used is preferably phenoloxidase, lignin peroxidase, manganese peroxidase or a mixture of these. A most suitable enzyme is phenoloxidase or laccase produced by white-rot fungus Coriolus versiculum. The temperature range of the enzyme treatment may be 10-90°C, preferably 40-70°C, and the pH range 2.0-10.0 preferably 4.0-8.0. When oxidizing enzymes such as phenoloxidase, lignin peroxidase and manganese peroxidase are used, it is preferable to adjust the redox potential to the optimum level characteristic of each

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oxidation-reduction enzyme by means of suitable oxidation-reduction chemicals or redox regulators, e.g. gaseous nitrogen or oxygen, antioxidants, sugars or sugar derivatives, organic acids or inorganic salts, used either by themselves or in mixtures.

In the following, the invention is described in detail by the aid of examples of embodiments based on laboratory tests.

Example 1.

2000 g of once-refined TMP spruce wood pulp was elutriated in tap water so that the mixture obtained had a consistency of 2.9%. By adding Coriolus versiculum laocase enzyme to the mixture, a mixture with a lacasse activity of 0.5 U/ml and an initial redox potential of approx. 100mV as measured against the Ptelectrode was obtained. The temperature of the mixture during the enzyme treatment was 20 °C and the treating time was 30 min.

After the enzyme treatment, sodium hydroxide (in an amount of 4% of the dry matter of the mixture) was added to the mixture. The mixture was then stirred manually for 30 min., whereupon it was concentrated, centrifugalized, homogenized and frozen.

The pulp was refined in a Sprout Waldron d 30 cm refiner with a diminishing blade distance. The refining energy was measured, whereupon a sample of 200 g (average) was taken. The sample was analyzed to determine its freeness value (CSF), fibre distribution, fibre length and shives content. In addition, a

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circulation water sheet was produced from the sample and analyzed to determine its density, tensile index, tear index, light scattering coefficient, light absorption coefficient and blue reflectance factor.

Tables 1 and 2 show the results of the analytical tests reflecting the refining result and the quality of the pulp. In addition to the above-described test (test 3) illustrating the invention, two reference tests (tests 1 and 2) and two additional tests (tests 4 and 5) were carried out. The results of these tests are also presented in Table 1 below. The tests were performed as follows:

Test 1 (reference test): No enzyme treatment and no water treatment of the pulp was carried out before refining. Neither was the pulp subjected to an alkali treatment. The refining and analyses were performed as above (test 3).

Test 2 (reference test): No enzyme treatment of the pulp was performed, but the pulp was treated with tap water in conditions corresponding to those of the enzyme treatment in test 3. In all other respects, the treatment corresponded to that described above (test 3).

Test 4: The pulp was subjected to an enzyme treatment in which the reaction mixture contained ascorbic acid in an amount of 0.3 g/l. Otherwise the test corresponded to that described above (test 3). The procedure represented by this test is within the scope of the present invention.

Test 5: The pulp was subjected to an enzyme treatment in which the reaction mixture contained ascorbic acid in an amount of 0.3 g/l and 10 mM of sodium chloride. Otherwise the test corresponded to that described above (test 3). The procedure represented by this test is within the scope of the present invention.

It can be seen from the results that the refining energy can be reduced during the first refining operation if once-refined TMP pulp is subjected to an enzyme treatment as provided by the invention.

It can also be seen that the the blue reflectance factor and certain strength properties were better than in the case of the control pulp.

It is obvious to a person skilled in the art that the invention is not restricted to the embodiment described above, but that it may instead be varied within the scope of the following claims.

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TABLE 1

Name of pulp	TEST 1		TEST 2		TEST 3		TEST 4		TEST 5					
	Untreated pulp		M0	0	I	M1	0	I	M2	0	I	M3	0	I
Solids content	% abt. 30		33.09	37.06		33.31	30.02		32.56	31.91		32.64	30.72	
CSF	410		410	330		410	320		410	315		410	315	
RESEARCH CENTRE	0		1	2		4	5		7	8		10	11	
Degree of beating	°FR	380	421	315		397	292		390	298		382	303	
Shives content	%	2.36	1.58	0.83		1.83	1.43		2.80	1.45		2.25	0.88	
Loss	%	12.64	8.16	7.46		9.23	6.46		9.80	7.29		13.29	8.54	
Bauer McNett classification														
30-fraction	%	45.0	47.1	44.2		47.3	46.6		46.6	44.2		46.1	43.4	
50-fraction	%	24.7	23.7	24.0		24.1	24.2		25.0	25.2		24.8	24.8	
100-fraction	%	7.7	7.3	7.0		7.6	7.4		7.6	7.5		7.8	7.6	
200-fraction	%	4.5	4.7	4.8		4.7	4.7		4.6	4.6		4.4	4.4	
Pass-through	%	18.6	17.2	20.0		16.3	17.1		16.2	18.5		16.9	19.8	
Fibre length Kajaani FS 200														
Arithm. average	mm	0.51	0.48	0.44		0.50	0.49		0.50	0.49		0.48	0.50	
L weight	mm	1.31	1.30	1.21		1.30	1.33		1.33	1.31		1.33	1.31	
W weight	mm	1.88	1.92	1.81		1.86	1.94		1.93	1.92		1.96	1.92	
0.20 mm p	%	44.34	46.68	48.60		45.11	46.07		44.92	45.04		47.70	43.65	
0.20 mm w	%	7.19	7.77	8.97		7.37	7.58		7.21	7.50		7.98	7.03	
Circul. water sheets no.		0	1	2		4	5		7	8		10	11	
Grammage	g/m ²	62.7	61.2	61.5		66.1	64.5		64.3	61.2		60.3	60.0	
Thickness	µm	226	208	194		220	198		218	192		203	185	
Density	kg/m ³	277	294	317		300	326		295	319		297	323	
Tensile index	Nm/g	19.6	19.1	24.9		21.2	25.6		21.8	25.9		21.8	27.0	
Elongation	%	1.5	1.3	1.6		1.5	1.6		1.5	1.7		1.5	1.5	
Tear index	mNm ² /g	5.38	5.88	6.67		5.79	6.90		5.56	6.94		5.82	6.08	
Light scatt. coeff. m ² /kg		46.0	43.0	42.0		42.2	41.6		42.2	44.4		42.3	42.4	
Light abs. coeff. kg/m ²		2.31	3.78	3.58		3.78	3.53		3.55	3.54		3.57	3.39	
Blue reflectance	%	57.7	49.6	50.2		49.3	50.3		50.0	51.4		49.8	51.2	

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TABLE 2

TEST 2		TEST 3		TEST 4		TEST 5	
Untreated pulp		Pulp with laccase		Pulp with laccase and ascorbic acid		Pulp with laccase, ascorbic acid and NaCl	
CSF	E MJ/kg	CSF	E MJ/kg	CSF	E MJ/kg	CSF	E MJ/kg
410	1.35	410	1.27	410	1.35	410	1.16
330		320		315		315	

E = refining energy

CSF = freeness

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED IS DEFINED AS FOLLOWS:

1. A process for the production of mechanical pulp from a fibrous product, wherein the fibrous product is subjected to an enzyme treatment in which the enzyme acts on lignin in the fibrous product.
2. The process according to claim 1, wherein the enzyme is an oxidizing enzyme and acts on the lignin in the fibrous product.
3. The process according to claim 2, wherein a redox potential is adjusted by means of an oxidation-reduction regulating chemical.
4. The process according to claim 3, wherein the oxidizing enzyme is a member selected from the group consisting of phenol-oxidase, lignin peroxidase, manganese peroxidase and a mixture of at least two of them; and the oxidation-reduction chemical is a member selected from the group consisting of gaseous nitrogen, gaseous oxygen, an antioxidant, a sugar or sugar derivative, an organic acid, an inorganic salt and a combination of at least two of them.
5. The process according to any of claims 1 to 4, wherein the enzyme treatment is conducted at a temperature of 10 to 90°C,

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and at a pH of 2.0 to 10.0.

6. A process for the production of mechanical pulp, which comprises:

subjecting raw wood mechanical pulp refined at least one time to a treatment with an oxidizing enzyme capable of acting on lignin contained in the refined pulp, where the enzyme treatment is conducted at a temperature of 10 to 90°C at a pH value of 2.0 to 10.0 while adjusting a redox potential of the enzyme by using a redox regulator.

7. The process according to claim 6, wherein the oxidizing enzyme is a member selected from the group consisting of phenoloxidase, lignin peroxidase, manganese peroxidase and a mixture thereof.

8. The process according to claim 6, wherein the oxidizing enzyme is laccase produced by white-rot fungus Coriolus versiculum.

9. The process according to claim 6, 7 or 8, wherein the raw wood pulp is thermomechanical pulp (TMP).

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